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METHOD OF ASSEMBLING THE
HEAT EXCHANGER CORE

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- Sir:

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Enclosed are:

- Specification, Claim(s), and Abstract (26 pages).
- Informal drawings (11 sheets, Figures 1-16).
- Unexecuted Declaration and Power of Attorney (4 pages).
- Assignment of the invention to
- Assignment Recordation Cover Sheet.
- Small Entity statement.
- Information Disclosure Statement.
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HEAT EXCHANGER CORE, AND METHOD OF
ASSEMBLING THE HEAT EXCHANGER CORE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a heat exchanger core constituted by connecting opposite ends of a header member with corresponding opposite ends of another header member, the latter header member being positioned opposite the former 10 header member through use of reinforcement members, as well as to a method of assembling the heat exchanger core.

The present application is based on Japanese Patent Applications No. Hei. 10-355699, 10-39704, and 11-345690 which are incorporated herein by reference.

15 2. Description of the Related Art

A core structure constituted by connecting opposite ends of a header member with corresponding opposite ends of another header member has already been known as the core of a heat exchanger, such as a radiator.

20 FIG. 13 shows the structure of a heat exchanger core of this type. In the heat exchanger core, header members 1, each comprising a header tank, are spaced away from and disposed opposite each other. Between the header members 1, tubes 3 and corrugated fins 5 are alternately arranged. The ends of one 25 of the headers member 1 are connected to the corresponding ends of the remaining header member 1 by means of reinforcement members 7.

More specifically, as shown in FIG. 14, in the heat

exchanger core of conventional structure, the reinforcement member 7 comprises the reinforcing section 7b having a C-shaped cross section and the insertion sections 7a which are continuous with the reinforcing section 7b and are to be inserted into the 5 corresponding reinforcement holes 1b. The thickness T1 of the reinforcement member 7, which is designed in terms of strength, is thinner than the thickness T2 of the tube 3. Further, the width W1 of the insertion section 7a is set to be smaller than the width W3 of the tube 3.

10 The ends of the respective tubes 3 are inserted into tube holes 1a formed in the header member 1, and the ends of the reinforcement member 7 are inserted into reinforcement holes 1b formed in the header member 1. In this state, the header members 1, the tubes 3, the corrugated fins 5, and the 15 reinforcement members 7 are connected together by means of brazing conducted within a heat treatment furnace.

More specifically, in the core structure of such a heat exchanger, insertion sections 7a as the ends of the reinforcement members 7 are fitted into the reinforcement holes 20 1b formed in the header members 1 and are fastened on the header members 1 by means of brazing. Accordingly, the reinforcement members 7 can reinforce the base ends of the tubes 3 attached to the both sides of the core structure, thus, four corners of the core structure on a plan view which are the most weak portions 25 in the core structure.

As shown in FIG. 15, in the core structure of such a heat exchanger, the tubes 3 and the corrugated fins 5 are arranged alternately, with the reinforcement members 7 being provided

at either end in the direction of arrangement, to thereby constitute a core section 10. In this state, the header members 1 are attached to opposite ends of the core section 10.

The corrugated fins 5 and reinforcing sections 7b of the reinforcement members 7 formed by bending so as to have a C-shaped cross section are guided along a horizontal guide surface 8a formed on a base member 8. Further, opposite ends of the respective tubes 3 are guide to individual tube guides 9 provided on opposite ends of the base member 8.

Further, as shown in FIG. 14, in the structure of the heat exchanger core, the width W2 of the reinforcing section 7b is set to be equal to the width W3' of the corrugated fin 5.

As shown in FIG. 16, in the heat exchanger core of conventional structure, the tube hole 1a and the reinforcement hole 1b, both being formed in the header member 1, differ in size from each other. In order to simultaneously form both the tube holes 1a and the reinforcement holes 1 in the header member 1, die assemblies for punching purposes corresponding to the length of the header member 1 must be prepared, thereby resulting in an increase in the number of types of die assemblies and hence adding to manufacturing costs.

Further, in the above method of assembling the heat exchanger core, the reinforcing sections 7b of the reinforcement members 7 are guided along the guide surface 8a of the base member 8 as shown in Fig. 15. It is very difficult to form the reinforcing section 7b of the reinforcement member 7 by bending with a high degree of accuracy, so machined dimensions of the reinforcement member 7 vary widely.

Therefore, the center of the insertion section 7a of the reinforcement member 7 and the center of the reinforcement hole 1b are shifted from each other with respect to the widthwise direction of the header member 1, thus causing a problem of 5 faulty insertion.

SUMMARY OF THE INVENTION

The present invention has been conceived to solve the problem of the traditional heat exchanger core and is aimed at 10 providing a heat exchanger core whose tube holes and reinforcement holes can be formed through use of single or fewer die assemblies even when header members have different lengths.

The present invention is also aimed at providing a heat exchanger core which prevents a deviation between the center 15 of a reinforcement hole and the center of an insertion section with respect to the widthwise direction of the header member, which would otherwise be caused when the core is inserted into header members, to a much greater extent than in a heat exchanger core of conventional structure.

According to the present invention, there is provided a 20 heat exchanger core comprising: a pair of header members being spaced with a predetermined clearance therebetween and disposed opposite to each other; tubes and corrugated fins which are interposed between the pair of header members and are arranged alternately; and a reinforcement member being provided on ends 25 of the mutually-opposing header members. Each of the header members has tube holes into which ends of the tubes are fixedly inserted and reinforcement holes into which ends of the

reinforcement members are fixedly inserted. Each of the reinforcement holes is formed so as to be of the same size as or larger than each of the tube holes. Further, an interval between the reinforcement hole and the tube hole adjacent to 5 the reinforcement hole is made equal to an interval between adjacent tube holes.

Preferably, the reinforcement hole is formed so as to be of the same size as each of the tube holes.

More preferably, the reinforcement hole comprises 10 circular-arch sections being formed at both ends thereof and a linear section being formed between the circular-arch sections, an insertion section is formed at the end of the reinforcement member so as to have a rectangular cross section and be fixedly inserted into the reinforcement hole, and a width 15 of the insertion section is made smaller than a width of the reinforcement hole as well as larger than a length of the linear section so that the insertion section is inserted into the reinforcement holes by press-fitting.

An interval between the linear section on a side of the 20 adjacent tube hole of the reinforcement hole and an end face of the header member may be made smaller than a value obtained by adding a size of a shorter side of the tube hole to the interval between the adjacent tube holes.

Further, according to the present invention, each of the 25 header members has tube holes into which ends of the tubes are fixedly inserted and reinforcement holes into which ends of the reinforcement members are fixedly inserted. The reinforcement member comprises a reinforcing section having a C-shaped cross

section and insertion sections which are integrally formed with opposite ends of the reinforcing section, and a width of the reinforcement member is smaller than a width of the corrugated fin.

5 Preferably, a width of the insertion section of the reinforcement member is substantially equal to a width of the tube.

10 More preferably, notches are formed on opposite sides of a base end section of the insertion section of the reinforcement member.

More preferably, chamfered sections are formed on opposite sides of a tip end of the insertion section.

15 Still further, according to the present invention, a method of assembling a heat exchanger core comprising steps of: guiding fins along a horizontal guide surface formed in a base member; guiding both ends of tubes and insertion sections of reinforcement members into tube guides which are provided on opposite sides of the base member while arranging alternately the fins and the tubes; placing the reinforcement members at 20 either end in the direction of arrangement of the fins and the tubes to thereby constitute a core section; and attaching header members to opposite sides of the core section.

25 In the structure of the heat exchanger core of the present invention, the size of the reinforcement hole is formed so as to be greater than the size of the tube hole, and the interval between the reinforcement hole and the tube hole adjacent to the reinforcement hole is made equal to the interval between adjacent tube holes.

In the structure of the heat exchanger core of the present invention, the reinforcement holes and the tube holes are formed so as to be of the same size.

5 In the structure of the heat exchanger core of the present invention, circular-arch sections are formed on opposite sides of the reinforcement hole, and the end of the reinforcement member having a rectangular cross section is inserted into the circular-arch section by press-fitting.

10 In the heat exchanger core of the present invention, the interval between the reinforcement hole and the end face of the header member is made smaller than a value obtained by adding the size of a shorter side of the tube hole to the interval between adjacent tube holes. Accordingly, formation of undesired tube holes at the end of the header member can be 15 prevented unfailingly.

15 In the heat exchanger core of the present invention, the width of the reinforcing section of the reinforcement member is made smaller than the width of the corrugated fin. At the time of assembly of the heat exchanger core, the opposite sides 20 of the respective tubes and the insertion sections of the reinforcement members are guided by tube guides for guiding corrugated fins disposed on opposite sides of the base member.

25 In the heat exchanger core of the present invention, the width of the insertion section of the reinforcement member is made substantially equal to the width of the tube. Hence, when the opposite sides of the respective tubes and the insertion sections of the reinforcement members are guided by tube guides, the center of the tube hole can be made substantially flush with

the center of the reinforcement hole with respect to the widthwise direction of the header member.

In the heat exchanger core of the present invention, notches are formed on opposite sides of the base end of the 5 insertion section of the reinforcing section.

In the heat exchanger core of the present invention, chamfered sections are formed on opposite sides of the tip end of the insertion section.

According to the method of assembling a heat exchanger 10 core of the present invention, the opposite sides of the tubes and the insertion sections of the reinforcement members are guided into the tube guides that are disposed on opposite sides of the base member, to thereby constitute a core section. In this state, the header members are attached to opposite sides 15 of the core section.

Features and advantages of the invention will be evident from the following detailed description of the preferred embodiments described in conjunction with the attached drawings.

20

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a bottom view showing details of a header member shown in FIG. 2;

25 FIG. 2 is a cross-sectional view showing a heat exchanger core of structure according to one embodiment of the present invention;

FIG. 3 is a descriptive view showing the relationship

between the size of a reinforcement member and the size of a corrugated fin;

FIGS. 4A to 4C are descriptive views showing the relationship between the size of the reinforcement member and 5 the size of a reinforcement hole;

FIG. 5 is a descriptive view showing a method of producing the reinforcement member shown in FIG. 1;

FIG. 6 is an enlarged view showing details of notches shown in FIG. 5;

10 FIG. 7 is a descriptive view showing a method of forming tube holes and reinforcement holes in the header member shown in FIG. 1;

15 FIG. 8 is descriptive view showing a method of forming tube holes and reinforcement holes when the head member is shorter than that shown in FIG. 7;

FIG. 9 is a descriptive view showing a process of assembling the heat exchanger core shown in FIG. 2;

FIG. 10 is a descriptive view showing a header member comprising a header plate;

20 FIGS. 11A and 11B are descriptive views showing other examples of the reinforcement holes formed in the header member;

FIG. 12 is a descriptive view showing another example of a method of forming tube holes and reinforcement holes in the header member;

25 FIG. 13 is a cross-sectional view showing a heat exchanger core of a conventional structure;

FIG. 14 is a descriptive view showing a conventional reinforcement member;

FIG. 15 is a descriptive view showing a process of assembling a conventional heat exchanger core; and

FIG. 16 is a front view showing tube holes and reinforcement holes formed in a conventional header member.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described in detail hereinbelow by reference to the accompanying drawings.

10 Fig. 1 shows a main part of Fig. 2 in detail, and Fig. 2 shows an embodiment of a heat exchanger core according to the present invention.

15 In FIG. 1, reference numeral 11 designates a pair of header members each of comprising a header tank, which are spaced apart with a clearance therebetween and are disposed opposite each other in a vertical direction.

20 Tube holes 11a are formed in each of the header members 11 at predetermined intervals in the longitudinal direction of the header member 11, and tubes 13 are fitted to the respective tube holes 11a.

Further, corrugated fins 15 and the tubes 13 are arranged alternately.

25 The ends of each of the header members 11 are connected to corresponding ends of the other header member 11 by means of reinforcement members 17.

A reinforcement hole 11b is formed in each of the ends of the header member 11, and an insertion section 17a of the reinforcement member 17 is fitted into and fixed to the

reinforcement hole 11b by means of brazing.

A patch end 19 is attached to each of the opposite ends of the header 11.

In the present embodiment, the header members 11, the 5 patch ends 19, the tubes 13, the corrugated fins 15, and the reinforcement members 17 are formed from aluminum. For example, after having been coated with non-corrosive flux, these elements are mutually brazed within a heat treatment furnace.

The header members 11, the patch ends 19, and the tubes 10 13 are made of clad material whose interior surface is coated with a sacrificial corrosive layer and whose exterior surface is coated with a brazing layer.

The reinforcement member 17 is made of clad material whose both sides are coated with a brazing layer, and the corrugated 15 fins 15 are made of bare material.

As shown in FIG. 1 in the present embodiment, the reinforcement hole 11b and the tube hole 11a of the header member 11 are formed so as to be of the same size ($W=W'$, $S=S'$).

Further, the interval L' between the reinforcement hole 20 11b and the tube hole 11a adjacent to the reinforcement hole 11b is made equal to the interval L between the adjacent tube holes 11a.

The interval T between a linear section 11d on the side of the adjacent tube hole 11a of the reinforcement hole 11b and 25 the end face of the header member 11 is made smaller than a value obtained by adding a size S of a shorter side of the tube hole 11a to the interval L between the adjacent tube holes 11a.

FIG. 3 shows details of the reinforcement member 17. The

reinforcement member 17 comprises a reinforcing section 17b having a C-shaped cross section, and insertion sections 17a which are to be fitted to the corresponding reinforcement holes 11b and are integrally formed with opposite sides of the 5 reinforcing section 17b.

Notches 17c are formed on opposite sides of the base end of the insertion section 17a. The width W4 of the reinforcing section 17b is made smaller than the width W5 of the corrugated fin 15.

10 Further, the width Wr of the insertion section 17a is made substantially equal to the width W6 of the tube 13.

Chamfered sections 17d are formed in opposite sides of the tip end of the insertion section 17a.

15 FIGS 4A to 4C show details relating to the relationship between the reinforcement hole 11b and the reinforcement member 17. In the embodiment, as shown in FIG. 4A, the reinforcement hole 11b comprises the linear section 11d and circular-arch sections 11c which are continuous with opposite ends of the linear section 11d.

20 As shown in FIG. 4B, the insertion section 17a of the reinforcement member 17 has a rectangular cross section.

Strictly speaking, the width W' of the reinforcement hole 11b is made larger than the width Wr of the insertion section 17a of the reinforcement member 17 by about 0.2 to 0.4 mm

25 As shown in FIG. 4C, the insertion section 17a of the reinforcement member 17 is inserted into the circular-arc sections 11c of the reinforcement hole 11b by press-fitting.

Accordingly, the reinforcement member 17 can be sturdily

supported on and fitted into the reinforcement hole 11b, thereby improving the brazing characteristic of the reinforcement hole.

FIG. 5 shows a method of producing the reinforcement member 17. Under this method, coil material 21 formed from 5 aluminum clad is continually supplied, and notches 23 are formed in the coil material 21 at regular intervals.

As shown in FIG. 5, a rectangular joint section 23a which is to be divided into a pair of the insertion sections 17a is formed in the notch 23, and a main body section 21a which is 10 to be formed into the reinforcing section 17b is formed on each side of the joint section 23a.

The notches 17c are formed on opposite sides of the base end of the joint section 23a. The notch 17c is cut at an angle θ of; for example, 15° to 60° and to a depth "d" of; for example, 15 0.5 to 1.5 mm.

A notch groove 23b which is to be divided into a pair of the chamfered sections 17d is formed in each of opposite sides of the center portion of the joint section 23a.

As shown in FIG. 5, the coil material 21 is cut along the 20 centerline running through the notch grooves 23.

Finally, the longitudinal side edges of the main body section 21a are bent along the notches 17c, to thereby form the reinforcing section 17b having a C-shaped cross section. Thus, there is produced the reinforcement member 17.

25 FIG. 7 shows a process of forming the tube holes 11a and the reinforcement holes 11b in the header member 11. In this process, the tube holes 11a and the reinforcement holes 11b are formed in the header member 11, by means of pressing punching

members 31, which are disposed at regular intervals on the upper die 29 in its longitudinal direction, into the header member 11 while the header member 11 is retained between the upper die 29 and the lower die 39.

5 In the present embodiment, a punching-members receiving member 33 and a backing-up bar 35 are inserted into the header member 11 having a rectangular cylindrical shape, and the header member 11 is placed in position by means of an abutment plate 37.

10 As shown in FIG. 8, in a case where the header members 11 have different lengths, the header member 11 is brought into contact with the abutment plate 37, and the punching members 31 disposed closer to the abutment plate 37 forms the tube holes 11a and the reinforcement holes 11b.

15 FIG. 9 shows a process of assembling the heat exchanger core of the present embodiment. In the embodiment, the tubes 13 and the corrugated fins 15 are arranged alternately, with the reinforcement members 17 being provided at either end in the direction of arrangement, to thereby constitute a core 20 section 24. In this state, the header members 11 are attached to opposite ends of the core section 24.

 In this state, only the corrugated fins 15 are guided along a horizontal guide surface 25a formed in the base member 25.

25 Tube guides 27 are disposed on opposite ends of the base member 25, and the opposite ends of the respective tubes 13 and the insertion sections 17a of the reinforcement members 17 are guided by tube guides 27.

In this state, the header members 11 are attached to either side of the core section 24, whereby the opposite sides of the respective tubes 13 and the insertion sections 17a of the reinforcement members 17 are retained by the guide tubes 27. As a result, the tubes 13 are fixedly inserted into the corresponding tube holes 11a formed in the header member 11, and the insertion sections 17a are fixedly inserted into the reinforcement holes 11b.

In the above heat exchanger core, the reinforcement holes 11b and the tube holes 11a are formed so as to be of the same size, and the interval L' between the reinforcement hole 11b and the tube hole 11a adjacent to the reinforcement hole 11b is made equal to the interval L between the adjacent tube holes 11a. Therefore, even in the case of the header members 11 having different lengths, the tube holes 11a and the reinforcement holes 11b can be formed in the header members 11 simultaneously through use of a single die assembly.

More specifically, as shown in FIG. 7, the tube holes 11a and the reinforcement holes 11b are formed in the header member 11, by means of pressing punching members 31, which are disposed at regular intervals on the upper die 29 in its longitudinal direction, into the header member 11. In the present embodiment, the tube holes 11a and the reinforcement holes 11b are formed so as to be of the same size, and the interval L' between the reinforcement hole 11b and the tube hole 11a adjacent to the reinforcement hole 11b is made equal to the interval L between the adjacent tube hole 11a. As a result, all the punching members 31 can be made of equal size. Even in the case of the

header members 11 having different lengths, the tube holes 11a and the reinforcement holes 11b can be formed in the header member 11 simultaneously.

Further, in the heat exchanger core, the interval T
5 between the linear section 11d on the side of the adjacent tube hole 11a of the reinforcement hole 11b and the end face of the header member 11 is made smaller than a value obtained by adding the size S of a shorter side of the tube hole 11a to the interval L between the adjacent tube holes 11a. Accordingly, formation
10 of undesired tube holes 11a at the end of the header member 11 can be prevented unfailingly.

In the structure of the heat exchanger core described above, the width W4 of the reinforcing section 17b of the reinforcement member 17 is made smaller than the width W5 of
15 the corrugated fin 15. The opposite sides of the respective tubes 13 and the insertion sections 17a of the reinforcement members 17 can be guided into the tube guides 27. As a result, there can be prevented interference between the reinforcement members 17 and the base member 25 for guiding the corrugated
20 fins 15, which would otherwise be caused

Since the insertion sections 17a of the reinforcement member 17 that are machined with a high degree of accuracy are guided into the tube guides 25, a displacement between the center of the reinforcement hole 11b and the center of the
25 insertion section 17a, which would otherwise be caused when the insertion sections 17a are inserted into the header members 11, can be diminished to a much greater extent than in the conventional heat exchanger core.

Further, in the structure of the heat exchanger core, the width W_r of the insertion section 17a of the reinforcement member 17 is made substantially equal to the width W_6 of the tube 13. Hence, the center of the tube hole 11a can be made 5 substantially flush with the center of the reinforcement hole 11b with respect to the widthwise direction of the header member 11, thereby imparting optimum reinforcement to the tubes 13 from the reinforcement members 17.

In the heat exchanger core, the notches 17c are formed 10 on opposite sides of the base end of the insertion section 17a of the reinforcement member 17. Hence, even when the width W_4 of the reinforcing section 17b is set to be smaller than the width W_r of the insertion section 17a, the reinforcing section 17b can be folded unfailingly.

15 The chamfered sections 17d are formed on opposite sides of the tip end of the insertion section 17a of the reinforcement member 17, thereby improving the ease of insertion of the insertion section 17a into the reinforcement hole 11b.

Under the method of assembling a heat exchanger core, 20 since the insertion sections 17a of the reinforcement member 17 that are machined with a high degree of accuracy are guided into the tube guides 25, a displacement between the center of the reinforcement hole 11b and the center of the insertion section 17a, which would otherwise be caused when the insertion 25 sections 17a are inserted into the header members 11, can be diminished to a much greater extent than in the conventional heat exchanger core.

Although the present embodiment has described

application of the present invention to the header member 11 comprising a header tank, the present invention is not limited to the present embodiment. For instance, the present invention can be applied to a header member comprising a header plate.

5 Fig. 10 shows a header member 11A comprising a header plate. This header member 11A is formed into a C-shaped cross section, and the tube holes 11a and the reinforcement holes 11b are formed on the bottom of the header member 11A.

Further, the width W5 of the corrugated fin 15 is set
10 larger than the width W6 of the tube 13 in the above embodiment. However, the present invention is not limited to this structure. For example, the present invention can be applied to the heat exchanger core in which the width W5 of the corrugated fin is equal to the width W6 of the tube.

15 Although the present embodiment has described application of the present invention to an example in which the tube holes 11a and the reinforcement holes 11b are formed so as to be of the same size, the present invention is not limited to the present embodiment. The tube holes and the reinforcement
20 holes may be formed so as to assume different geometries.

More specifically, after the tube holes 11a and the reinforcement holes 11b have been formed to assume an identical geometry, the ends of the reinforcement hole 11b are additionally machined into a rectangular shape, as shown in FIG.
25 11A, to thereby form rectangular reinforcement holes 11e.

Alternatively, as shown in FIG. 11B, the width of a reinforcement hole 11f may be set to be greater than the width of the tube hole 11a.

Although the previous embodiment has described the present invention by reference to the example in which the tube holes 11a and the reinforcement holes 11b are formed after the header members 11 and 11A have been cut to a predetermined length, 5 the present invention is not limited to such an embodiment. The tube holes and the reinforcement holes may be formed before cutting of the header member.

More specifically, as shown in FIG. 12, both ends of plate material 51, the plate being continually supplied at a predetermined speed, are folded so as to assume a C-shaped geometry, by means of an upper rolling die 41 and a lower rolling die 43. The tube holes 11a and the reinforcement holes 11b may be formed by means of an upper die 45 and a lower die 47, and plate material having a C-shaped geometry may be cut to a predetermined length through use of a cutting blade 49. 10 15

Although the present embodiment has described application of the present invention to a radiator, the present invention is not limited to such an embodiment. For instance, the present invention can be applied to a different type of heat 20 exchanger; for example, a condenser.

Although the present embodiment has described the example in which the header member 11 comprising a header tank is formed so as to assume a rectangular cylindrical shape, the present invention is not limited to the present embodiment. For 25 instance, the header member may be formed so as to assume a circular cylindrical shape.

The insertion section 17a of the reinforcement member 17 may assume any geometry, so long as the reinforcement hole 11b

can be completely and hermetically sealed by connecting the insertion section 17a into the reinforcement hole 11b through brazing.

As has been described above, in the structure of the heat exchanger core of the present invention, the size of the reinforcement hole is formed so as to be greater than the size of the tube hole, and the interval between the reinforcement hole and the tube hole adjacent to the reinforcement hole is made equal to the interval between the adjacent tube holes. As a result, in a case where the header members have different lengths, the tube holes and the reinforcement holes can be simultaneously formed in the header member through use of a fewer number of die assemblies.

In the structure of the heat exchanger core of the present invention, the reinforcement holes and the tube holes are formed so as to be of the same size. As a result, in a case where the header members have different lengths, the tube holes and the reinforcement holes can be simultaneously formed in the header member through use of a single die assembly.

In the structure of the heat exchanger core of the present invention, circular-arch sections are formed at either end of the reinforcement hole, and the end section of the reinforcement member having a rectangular cross section is fitted into the circular-arch sections of the reinforcement hole by press-fitting. The reinforcement member can be sturdily supported on and fitted into the reinforcement hole, thereby improving the brazing characteristic of the reinforcement hole.

In the heat exchanger core of the present invention, the

interval between the reinforcement hole and the end face of the header member is made smaller than a value obtained by adding the size of a shorter side of the tube hole to the interval between adjacent tube holes. Accordingly, formation of 5 undesired tube holes at the end of the header member can be prevented unfailingly.

In the heat exchanger core of the present invention, the width of the reinforcing section of the reinforcement member is made smaller than the width of the corrugated fin.

10 In the heat exchanger core described above, since the width of a reinforcing section is made smaller than the width of a corrugated fin, both ends of tubes and the insertion sections of the reinforcement members can be guided by the tube guides. Therefore, there can be prevented interference 15 between the reinforcement members and a base member for guiding the corrugated fins.

Since the insertion sections of the reinforcement member that are machined with a high degree of accuracy are guided into the tube guides, a displacement between the center of the 20 reinforcement hole and the center of the insertion section, which would otherwise be caused when the insertion sections are inserted into the header members, can be diminished to a much greater extent than in the conventional heat exchanger core.

In the heat exchanger core of the present invention, the 25 width of the insertion section of the reinforcement member is made substantially equal to the width of the tube. Hence, when the opposite sides of the respective tubes and the insertion sections of the reinforcement members are guided by tube guides,

the center of the tube hole can be made substantially flush with the center of the reinforcement hole with respect to the widthwise direction of the header member, thereby imparting optimum reinforcement to the tubes from the reinforcement members.

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In the heat exchanger core of the present invention, since notches are formed on opposite sides of the base end of the insertion section of the reinforcing section, a reinforcing section can be bent unfailingly.

10

In the heat exchanger core of the present invention, chamfered sections are formed on opposite sides of the tip end of the insertion section, and hence the ease of insertion of the insertion section into the reinforcement hole can be improved.

15

According to the method of assembling a heat exchanger core of the present invention, since the insertion sections of the reinforcement member that are machined with a high degree of accuracy are guided into the tube guides, a deviation between the center of the reinforcement hole and the center of the insertion section, which would otherwise be caused when the insertion sections are inserted into the header members, can be diminished to a much greater extent than in the conventional heat exchanger core.

20

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form can be arrangement of parts without departing from the spirit and the scope of the invention as hereinafter claimed.

25

WHAT IS CLAIMED IS:

1. A heat exchanger core comprising:
a pair of header members being spaced with a predetermined
clearance therebetween and disposed opposite to each other;
5 tubes and corrugated fins which are interposed between
said pair of header members and are arranged alternately; and
a reinforcement member being provided on ends of said
mutually-opposing header members,
wherein each of said header members has tube holes into
10 which ends of said tubes are fixedly inserted and reinforcement
holes into which ends of said reinforcement members are fixedly
inserted,
wherein each of said reinforcement holes is formed so as
to be of the same size as or larger than each of said tube holes,
15 and
wherein an interval between said reinforcement hole and
said tube hole adjacent to said reinforcement hole is made equal
to an interval between adjacent tube holes.
- 20 2. A heat exchanger core according to claim 1, wherein
wherein each of said tube holes is formed so as to be of the
same size as each of said reinforcement holes.
- 25 3. A heat exchanger core according to claim 2, wherein
said reinforcement hole comprises circular-arch sections being
formed at both ends thereof and a linear section being formed
between said circular-arch sections,
an insertion section is formed at the end of said

reinforcement member so as to have a rectangular cross section and be fixedly inserted into said reinforcement hole, and a width of said insertion section is made smaller than a width of said reinforcement hole as well as larger than a length of 5 the linear section so that said insertion section is inserted into said reinforcement holes by press-fitting.

4. A heat exchanger core according to claim 1, wherein an interval between the linear section on a side of the adjacent 10 tube hole of said reinforcement hole and an end face of said header member is made smaller than a value obtained by adding a size of a shorter side of said tube hole to the interval between the adjacent tube holes.

15 5. A heat exchanger core comprising:
a pair of header members being spaced with a predetermined clearance therebetween and disposed opposite to each other; and
tubes and corrugated fins which are interposed between said pair of header members and are arranged alternately,
20 a reinforcement member being provided on ends of said mutually-opposing header members,
wherein each of said header members has tube holes into which ends of said tubes are fixedly inserted and reinforcement holes into which ends of said reinforcement members are fixedly 25 inserted, said reinforcement member comprises a reinforcing section having a C-shaped cross section and insertion sections which are integrally formed with opposite ends of said reinforcing section, and a width of said reinforcement member

is smaller than a width of said corrugated fin.

6. A heat exchanger core according to claim 5, wherein
a width of said insertion section of said reinforcement member
5 is substantially equal to a width of said tube.

7. A heat exchanger core according to claim 5, wherein
notches are formed on opposite sides of a base end section of
said insertion section of said reinforcement member.

10

8. A heat exchanger core according to claim 5, wherein
chamfered sections are formed on opposite sides of a tip end
of said insertion section.

15

9. A method of assembling a heat exchanger core
comprising steps of:

guiding fins along a horizontal guide surface formed in
a base member;

guiding both ends of tubes and insertion sections of
20 reinforcement members into tube guides which are provided on
opposite sides of the base member while arranging alternately
the fins and the tubes;

25 placing the reinforcement members at either end in the
direction of arrangement of the fins and the tubes to thereby
constitute a core section; and

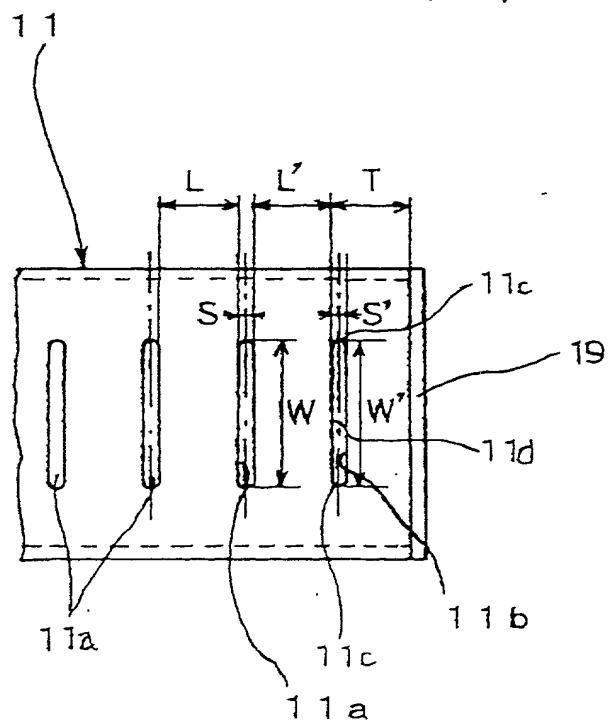
attaching header members to opposite sides of the core
section.

ABSTRACT OF THE DISCLOSURE

Reinforcement holes and tube holes are formed so as to be of the same size, and the interval between the reinforcement hole and the tube hole adjacent to the reinforcement hole is
5 made equal to the interval between the adjacent tube holes.

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FIG. 1



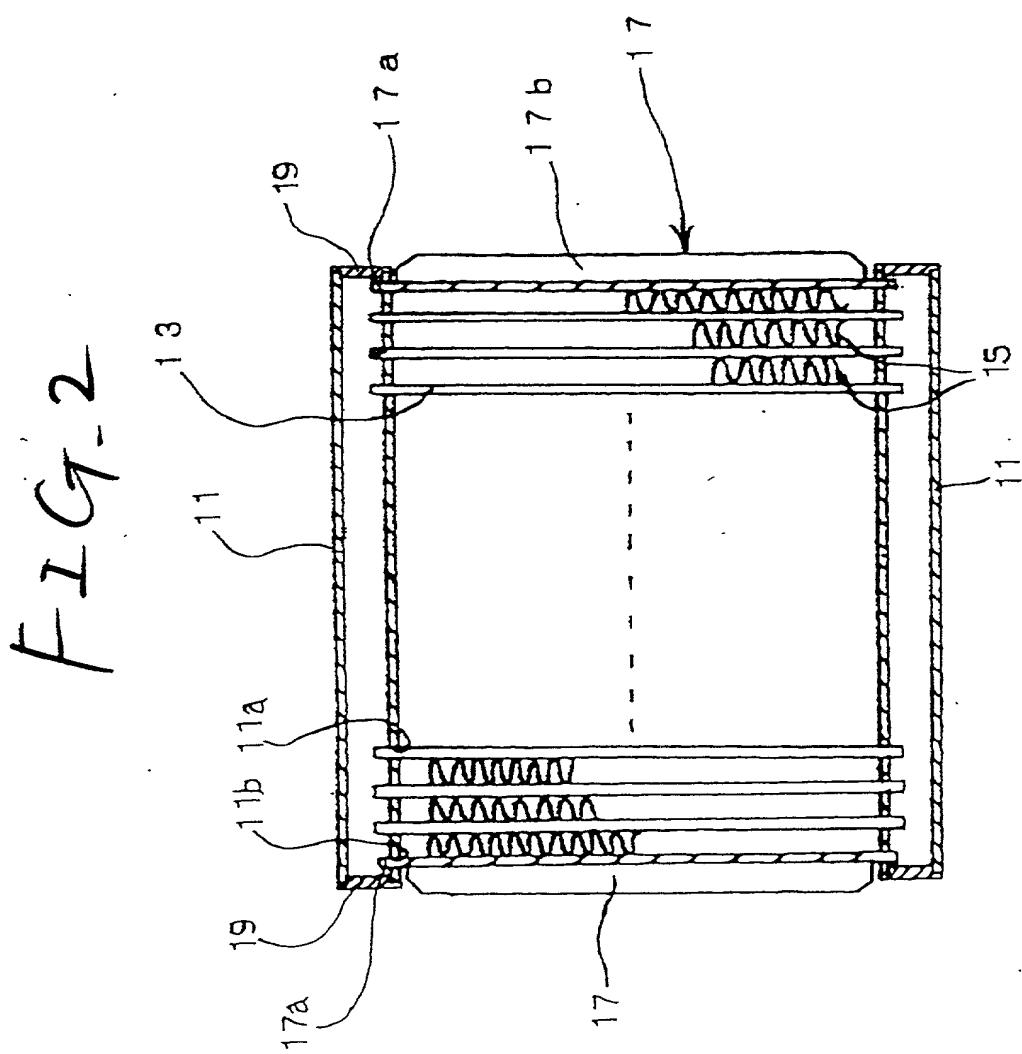


FIG. 3

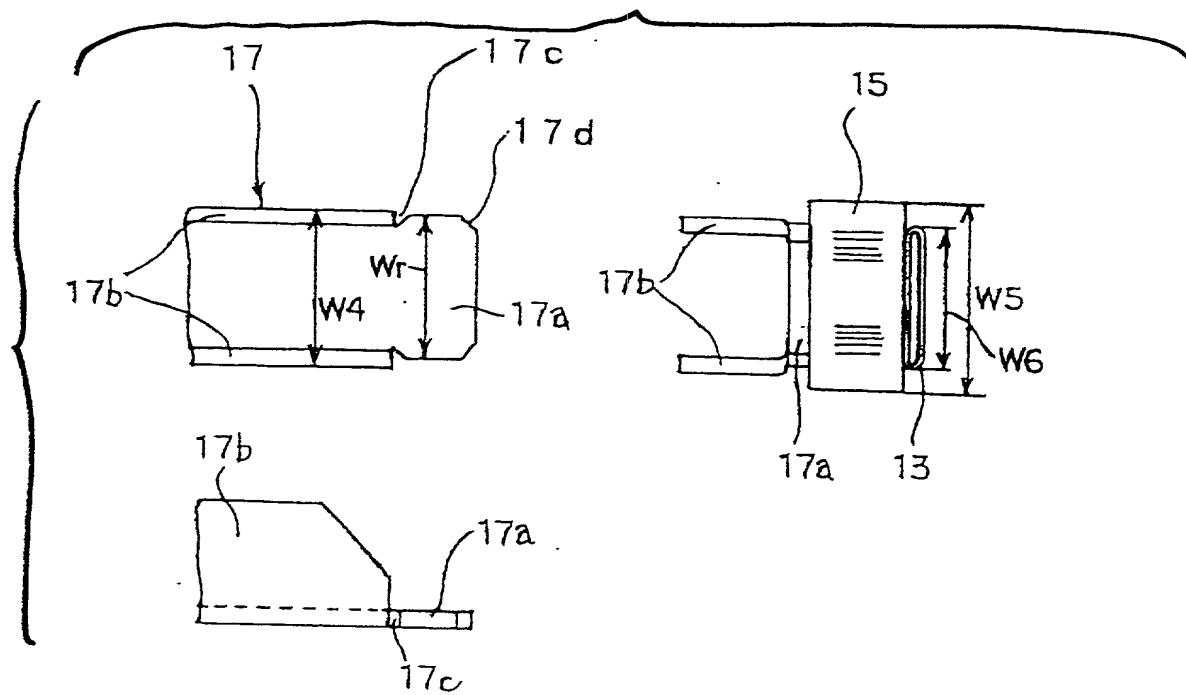


FIG. 4A

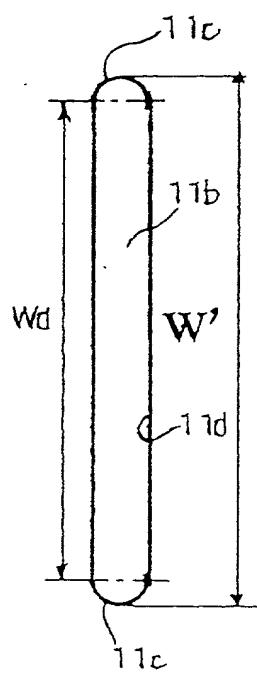


FIG. 4B

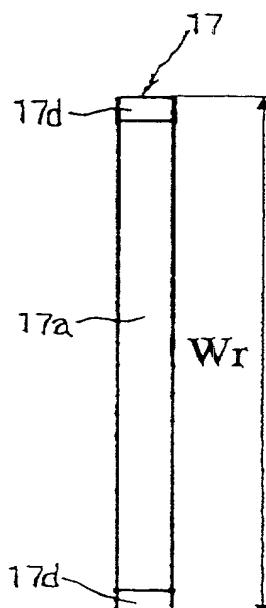


FIG. 4C

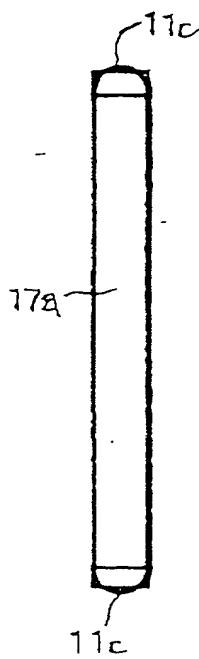


FIG. 5

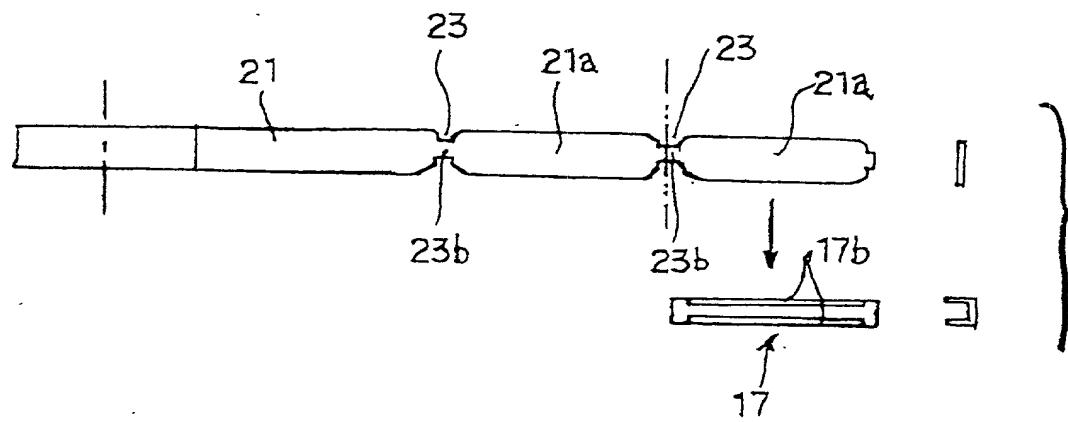


FIG. 6

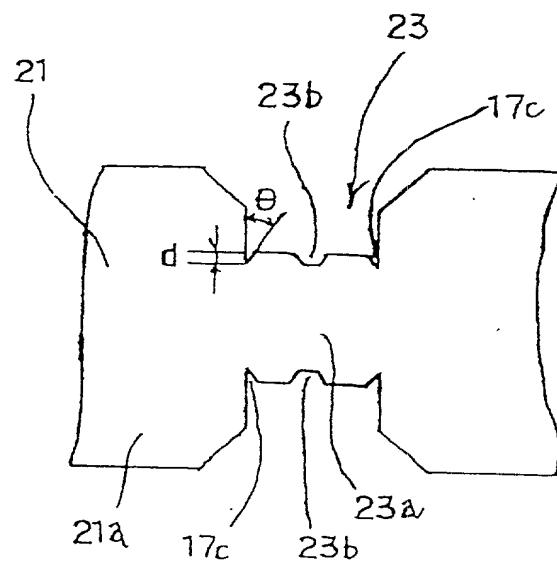


FIG. 7

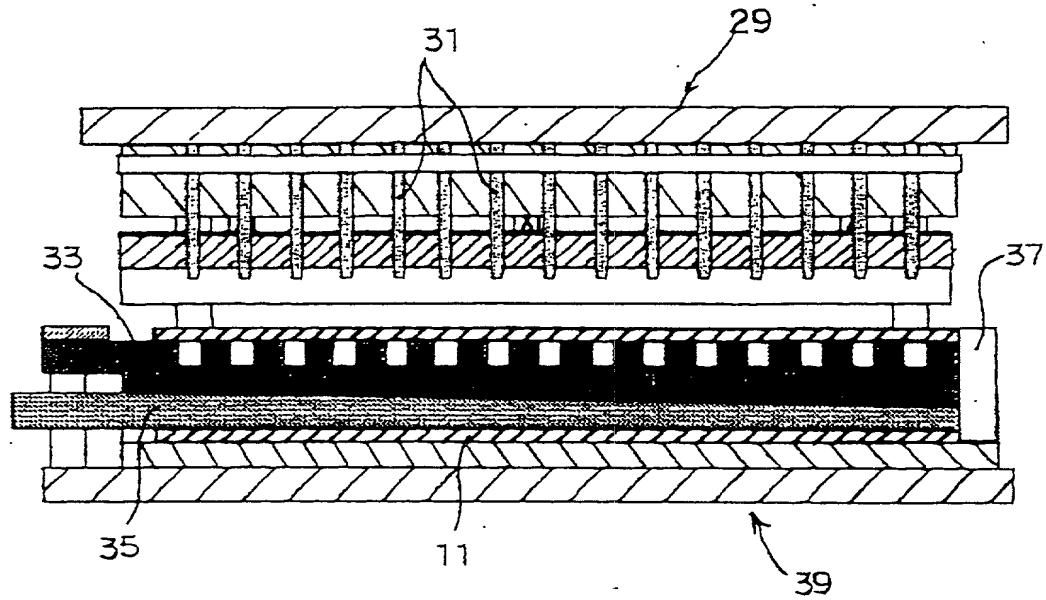


FIG. 8

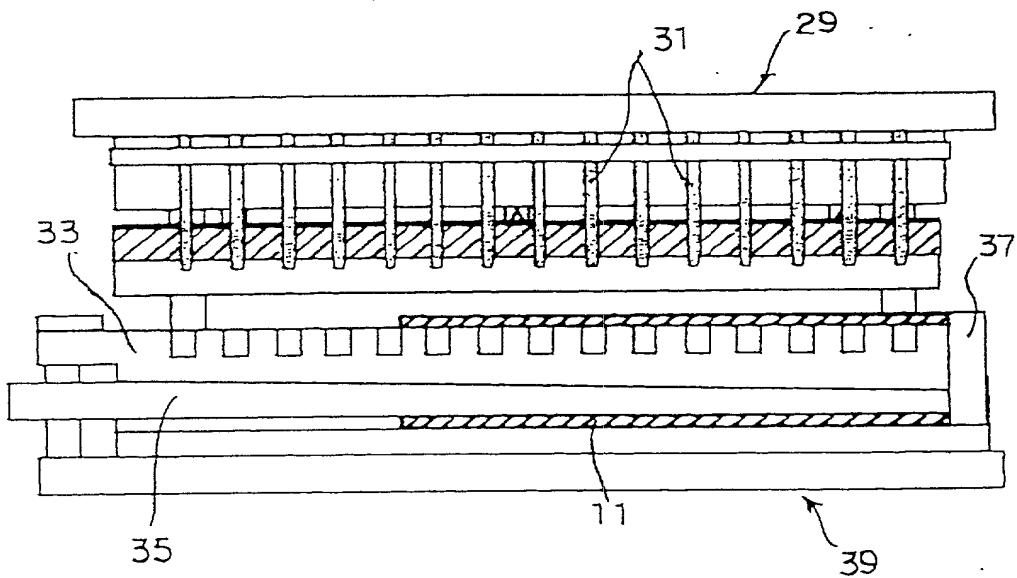


FIG. 9

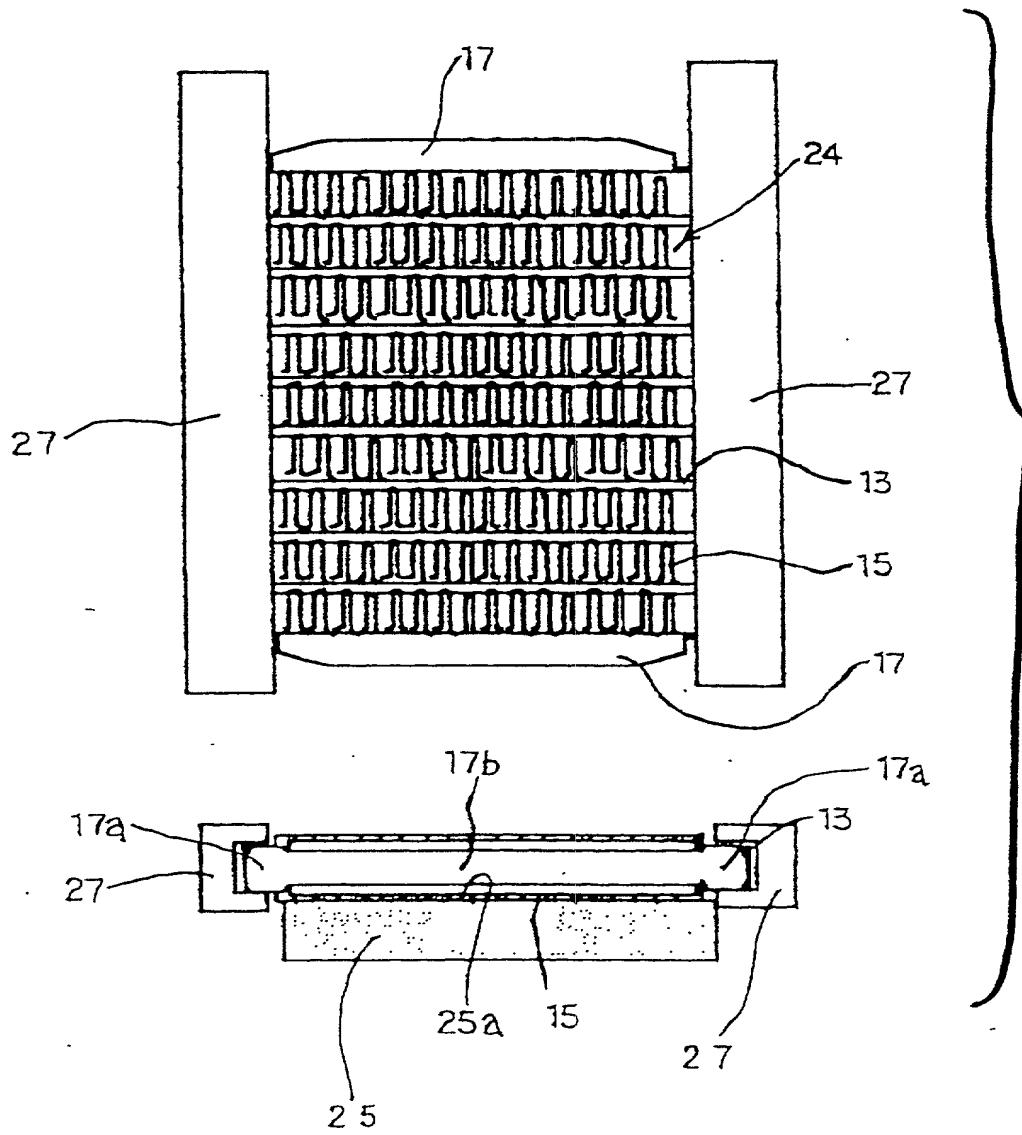


FIG. 10

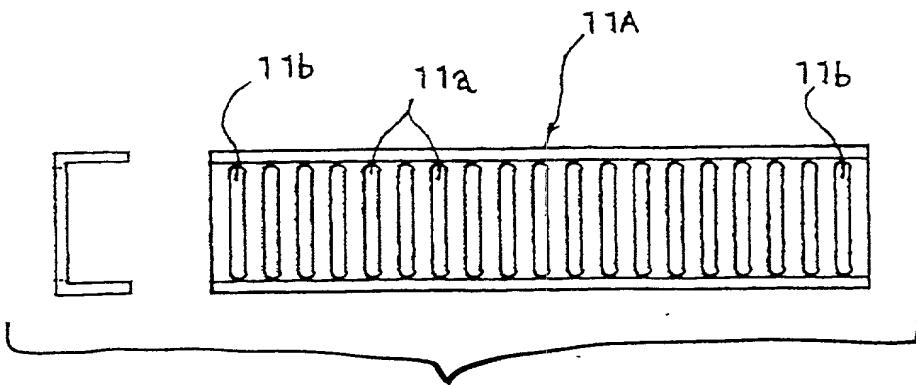


FIG. 11A

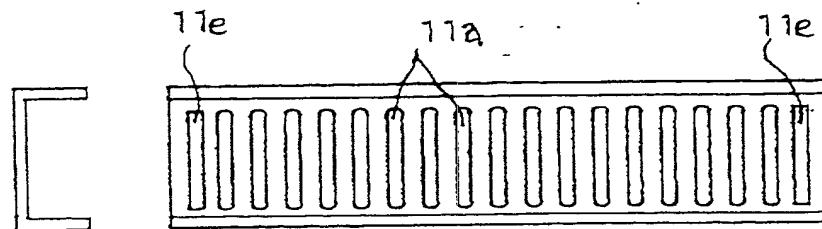


FIG. 11B

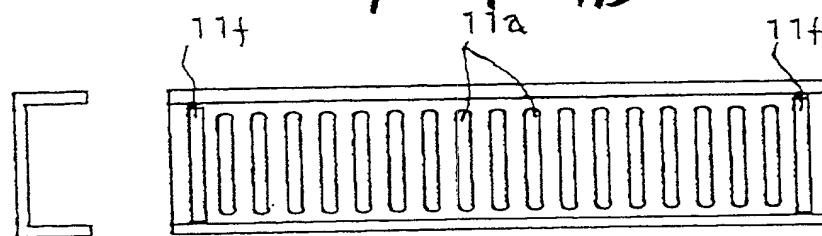


FIG. 1/2

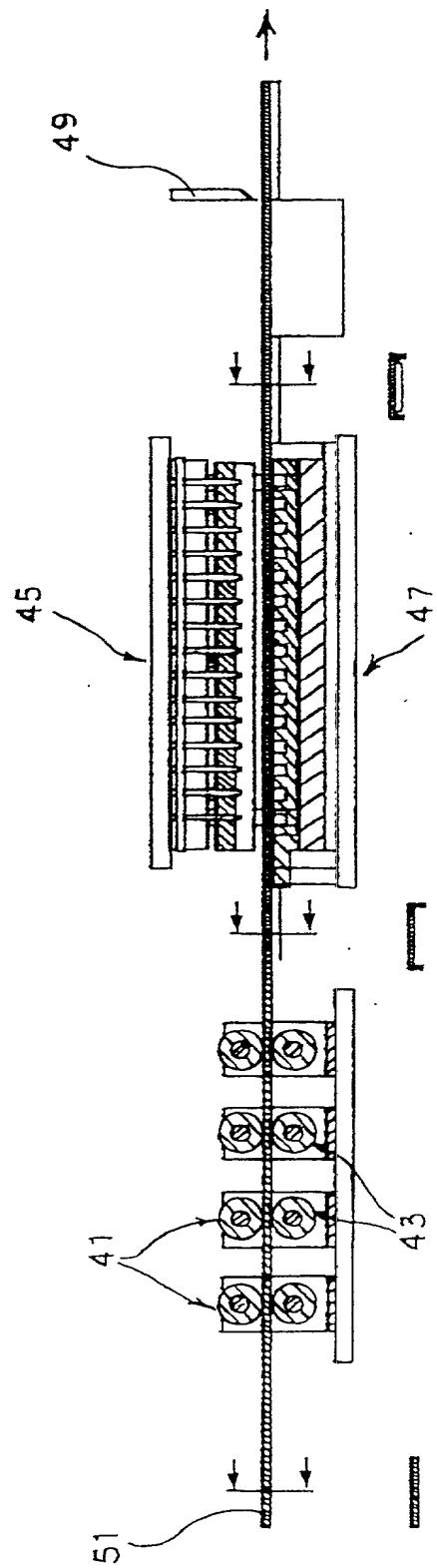


FIG. 13

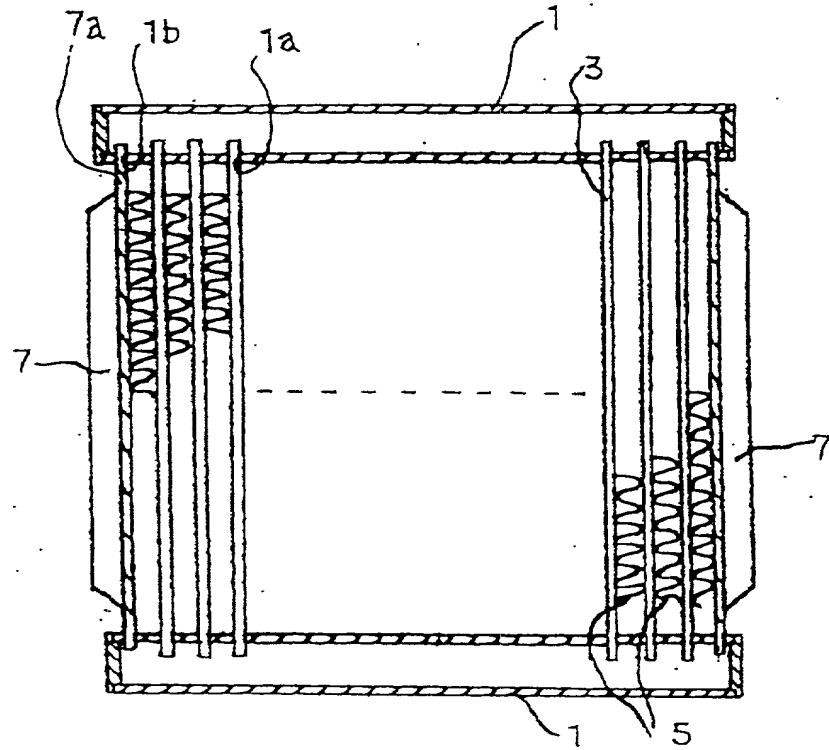


FIG. 14

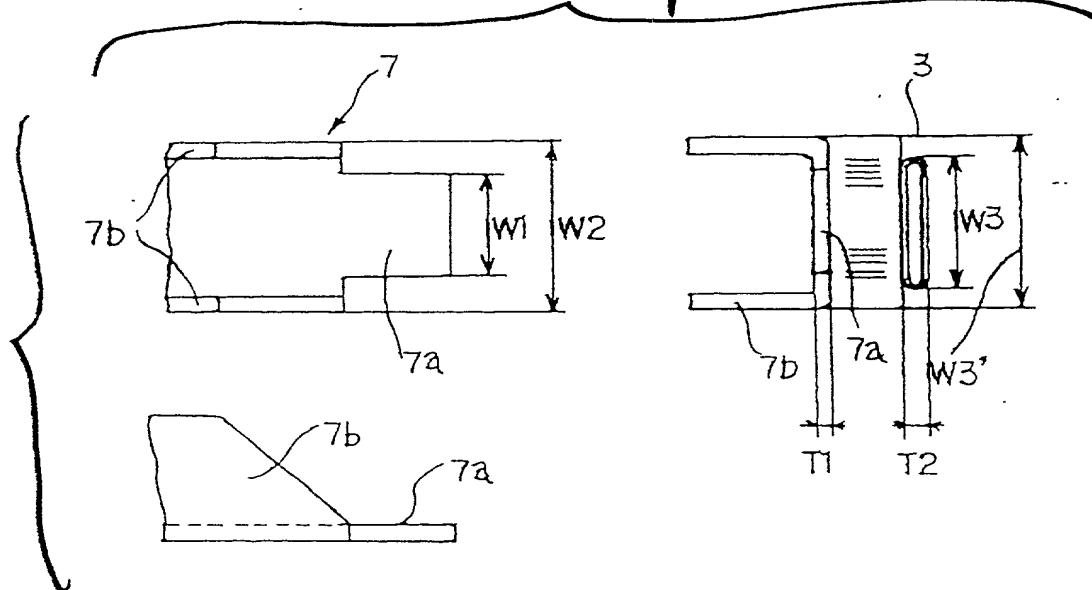


FIG. 15

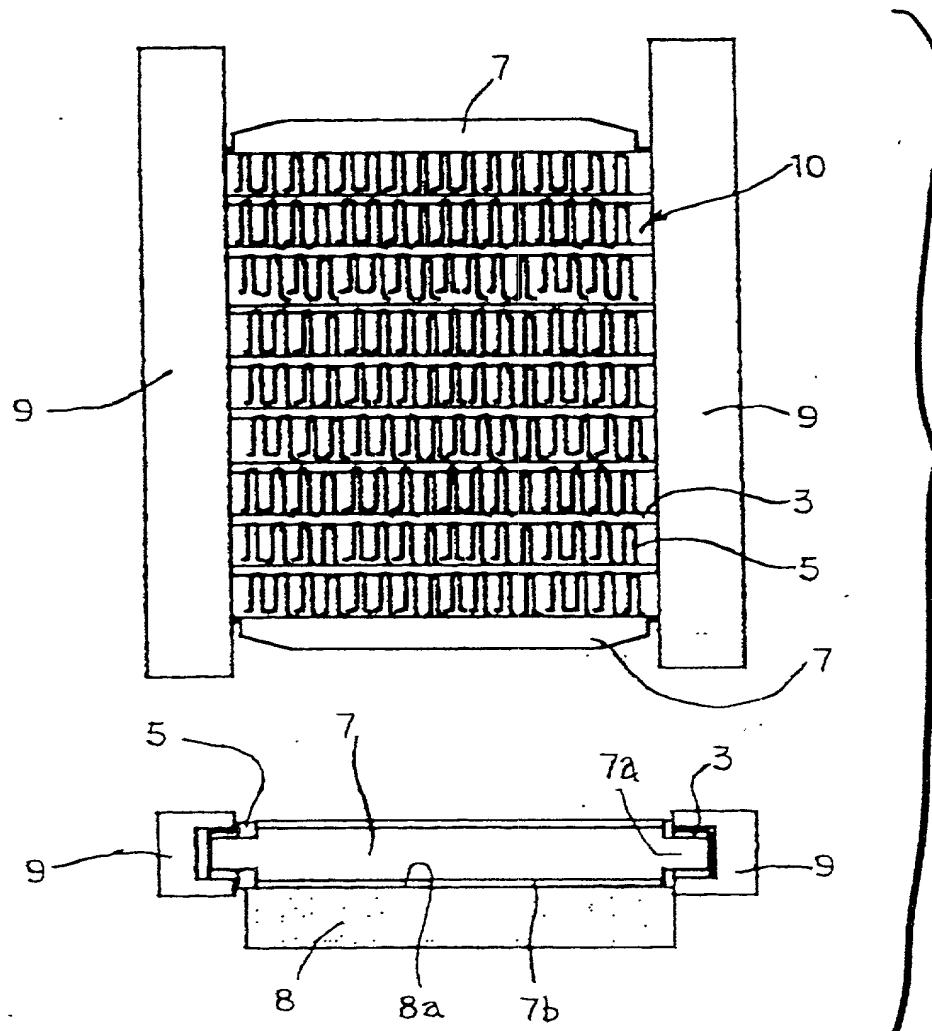
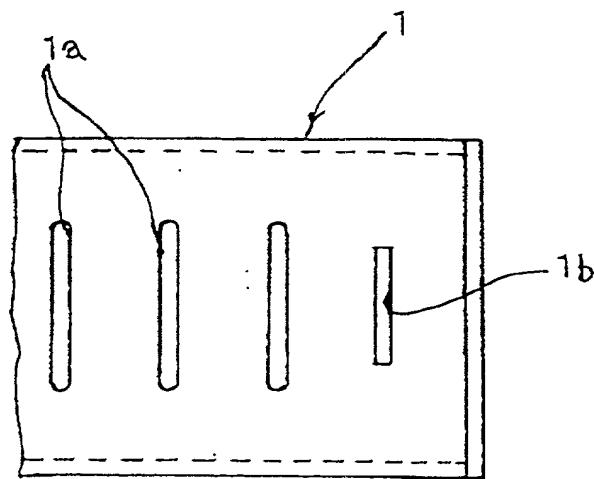


FIG. 16



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HEAT EXCHANGER CORE, AND METHOD OF ASSEMBLING THE HEAT EXCHANGER CORE

(Attorney Docket No. 018889/0156)

the specification of which (check one)

is attached hereto.

was filed on December 15, 1999 as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

THAT I do not know and do not believe that the same invention was patented or described in any printed publication in any country, or in public use or on sale in the United States of America, for more than one year prior to the filing date of this United States application;

THAT I do not know and do not believe that the same invention was first patented or made the subject of an inventor's certificate that issued in any country foreign to the United States of America before the filing date of this United States application if the foreign application was filed by me (us), or by my (our) legal representatives or assigns, more than twelve months (six months for design patents) prior to the filing date of this United States application;

THAT I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment specifically referred to above;

THAT I believe that the above-identified specification contains a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention, and sets forth the best mode contemplated by me of carrying out the invention; and

THAT I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I HEREBY CLAIM foreign priority benefits under Title 35, United States Code §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?
10-355699	Japan	December 15, 1998	Yes	
11-039704	Japan	February 18, 1999	Yes	
11-345690	Japan	December 6, 1999	Yes	

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date

I HEREBY CLAIM the benefit under Title 35, United States Code, §120 of any United States application(s), or § 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

I HEREBY APPOINT the following registered attorneys and agents of the law firm of FOLEY & LARDNER to have full power to prosecute this application and any continuations, divisions, reissues, and reexaminations thereof, to receive the patent, and to transact all business in the United States Patent and Trademark Office connected therewith:

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BERNHARD D. SAXE	Reg. No. 28,665
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I UNDERSTAND AND AGREE THAT the foregoing attorneys and agents appointed by me to prosecute this application do not personally represent me or my legal interests, but instead represent the interests of the legal owner(s) of the invention described in this application.

I FURTHER DECLARE THAT all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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Date	_____

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Date	